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# State of Utah

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August 20, 1992

**TO:** Division Guideline Folder

**FROM:** Staff Hydrologists 

**RE:** Position Paper on Design Storm Event Criteria Relative to Design and Approval of Temporary Diversions for Miscellaneous Flows

## SUMMARY

The design event criteria set forth in Rules R645-301-742.320 and R645-301-742.330 needs clarification to ensure consistent application of the rules in our reviews. Specifically, it was decided to develop a position paper for use as a working guideline in the preparation of permit applications by the Operators and for our reviews. The issue is the application of Rule R645-301-742.333 which specifies design event criteria for diversions of miscellaneous flows. The rule allows the use of a 2 yr. - 6 hr. precipitation event in the design of temporary diversions.

The Division's concern is that the design of diversions using the 2 year event criteria of R645-301-742.333 for operational diversions will result in diversion failures. In underground mining, operational diversions will typically be installed, maintained and relied upon during the entire life of mine. Failure of these diversions could jeopardize pond performance and safety, increase sediment loading to the pond, and potentially cause off-site increases in sediment loads. It is felt that the approval of such designs is actually a disservice to the Operator in terms of increased enforcement liability, diversion maintenance costs, and protection of the hydrologic balance.

The R645 rules define temporary diversions as those that are not approved by the Division to remain after reclamation as part of the approved postmining land use. For an underground coal mine, these diversions could be in place for 20 - 30 years during the life of the operational facilities. The guideline provides permitting direction that will recommend the use of 10 year - 6 hour design events for those long term operational diversions. Diversions that have a short design life (on the order of months) will be allowed to be designed using the 2 yr. - 6 hr. event.

## Guideline Diversion Design Event Criteria

### I. STATEMENT OF RULES

The applicable rules are presented as an attachment to this paper for reference to aid in the discussion and development of the working guideline (Attachment C). In summary, the current R645 rules and the Federal CFR rules are essentially identical with regard to the use of 2 year return period events for the design of temporary diversions of miscellaneous flows. The "old" UMC rules clarified the use of the 2 year event with the following language: "However, temporary diversions designed to divert runoff from sediment ponds must be designed and constructed to pass safely the peak runoff from a 10-year, 24 hour precipitation event." In other words, the intent of the rule was to ensure that all flows diverted away from a sediment pond were controlled by diversions able to pass flows consistent with the pond design (10 year, 24 hour event). The R645 rules did not specifically retain this language, but rules providing for consistent, prudent, standard engineering practice would still incorporate this philosophy.

#### Current Rules (R645-301, ET. SEQ.):

- 732.300. Diversions. All diversions will be constructed and maintained to comply with the requirements of R645-301-742.100 and R645-301-742.300.
- 742.300. Diversions.
- 742.314. The Division may specify additional design criteria for diversions to meet the requirements of R645-301-742.300.
- 742.330. Diversion of Miscellaneous Flows.
- 742.331. Miscellaneous flows, which consist of all flows except for perennial and intermittent streams, may be diverted away from disturbed areas if required or approved by the Division. Miscellaneous flows will include ground-water discharges and ephemeral streams.
- 742.333. The requirements of R645-301-742.312.2 will be met when the temporary and permanent diversions for miscellaneous flows are designed so that the combination of channel, bank and floodplain configuration is adequate to

pass safely the peak runoff of a 2-year, 6-hour precipitation event for a temporary diversion and a 10-year, 6-hour precipitation event for a permanent diversion.

## FEDERAL RULES

### Sec. 817.43 Diversions.

(2) The diversion and its appurtenant structures shall be designed, located, constructed, and maintained to--

- (i) Be stable;
- (ii) Provide protection against flooding and resultant damage to life and property;
- (iii) Prevent, to the extent possible using the best technology currently available, additional contributions of suspended solids to streamflow outside the permit area; and
- (iv) Comply with all applicable local, State, and Federal laws and regulations.

(4) The regulatory authority may specify additional design criteria for diversions to meet the requirements of this Section.

(c) Diversion of miscellaneous flows. (1) Miscellaneous flows, which consist of all flows except for perennial and intermittent streams, may be diverted away from disturbed areas if required or approved by the regulatory authority. Miscellaneous flows shall include ground-water discharges and ephemeral streams.

(2) The design, location, construction, maintenance, and removal of diversions of miscellaneous flows shall meet all of the performance standards set forth in Paragraph (a) of this Section.

(3) The requirements of Paragraph (a)(2)(ii) of this Section shall be met when the temporary and permanent diversions for miscellaneous flows are designed so that the combination of channel, bank and flood-plain configuration is adequate to pass safely the peak runoff of a 2-year, 6-hour precipitation event for a temporary diversion and a 10-year, 6-hour precipitation event for a permanent diversion.

## II. LEGISLATIVE HISTORY AND RULE INTENT

In the preamble to SMCRA, diversion design event criteria is not discussed specifically. The preamble discussion centers around the fact that the hydrologic balance regulations are:

"structured on the premise that the applicant for a permit will research and understand the hydrologic balance in the mine plan and adjacent areas prior to mining, as well as understand the potential impacts of mining on

that balance, so that operations are planned and conducted to minimize disturbances to the hydrologic balance both on-site and off-site." 44 CFR 14902 March 13, 1979

According to 48 CFR 43956, Federal Register, September 26, 1983, a discussion on diversions was presented. A complete copy of this section is attached. Diversions are specified in Sections 816.43(a) - 816.43(a) and 817.43(c) - 817.43(c).

"Paragraph 816.43(a)(2) and 817.43(a)(2) requires that the design, location, construction, maintenance, and use of the diversion and its appurtenant structures will ensure stability; provide protection against flooding and resultant damage to life and property; prevent additional contributions of suspended solids to streamflow outside the permit area; . . .".

The key words here are design, stability, and protection against flooding.

### **General Requirements**

Section 816.43(a)(3) and 817.43(a)(3) provides authority to the regulatory authority (RA) to "specify additional design criteria for diversions." Diversion as discussed in this context continues to reflect diversions as a means of diverting un-regulated water away from a regulated mine site. Specifically, the discussion mentions pre-existing flows, undisturbed flows, and flows from mines abandoned prior to May 3, 1978.

### **Diversion of Perennial and Intermittent Streams**

Section 816.43(b) and 817.43(b) covers diversions of perennial and intermittent streams. This refers to stream channel diversions in the mine area. Designs for these segments reflect channel configurations similar to those existing above and below the channel in question and do not affect the design of diversions for disturbed areas.

### **Diversions of Miscellaneous Flows**

Section 816.43(c) and 817.43(c) governs diversions of miscellaneous flows. Disturbed area diversions would fall under this category. A discussion in the June 25, 1982, Federal Register indicates that an operator is required to design diversions to prevent flooding to life and property. This proposed rule states:

"Proposed rule 816.41(f)(2)(iii) and 817.41(f)(2)(iii) would also provide the operator flexibility in meeting the flooding, life and property damage requirements of proposed rule 816.41(f)(i)(B) and 817.41(f)(i)(B). This flexibility is available under the condition that the operator voluntarily choose to design temporary and permanent diversions to handle the 2-year, 24-hour and the 10-year, 24-hour events for temporary and permanent diversions, respectively. OSM anticipates that this will encourage sound engineering practices while reducing the cost of designing and constructing diversions by allowing local needs to govern their size."

This discussion shows that the intent of the law in 1982, was to provide design criteria to reduce flooding; damage to life and property; to reduce additional contributions of suspended solids to streamflow outside the permit area; and to protect the hydrologic balance in and adjacent to the permit area. The rules that were promulgated reflect the 2-year, 6-hour event and not the originally proposed 2-year 24-hour event.

The final rules provide the RA with sufficient authority to address environmental concerns with respect to miscellaneous flows without necessitating the listing of limitations as previously was the case. It also provides the RA authority to specify design criteria specific to a particular regional climate and topography and expected diversion design life.

### III. TECHNICAL DISCUSSION

#### a) Probability Theory and Utah Diversions

The objective of this section is to present the basis of probability theory used in risk analysis for the selection of an appropriate design event return period. A summary of example design events typical to Utah operations is presented.

The selection of an event to be used for the design of a given structure incorporates three concepts: 1) life of the structure (design life), 2) level of acceptable risk, and 3) recurrence interval for the event. Given any two of these values allows calculation of the third. Most often the return period is the unknown to be determined. This will be the focus of this discussion. Implicit in the risk level selection are economic factors (i.e. costs to repair and mitigate environmental damage/loss of life, costs to replace structure, costs associated with loss of use of structure). Once the design life of the structure and the level of risk are determined, the recurrence interval of the design event can be calculated. The formulas for this calculation are

founded in basic probability theory unrelated to hydrologic factors. The formula for the calculation of the recurrence interval with design life and risk level given is as follows:

$$Tr = \frac{1}{1-(1-J)^{1/n}}$$

where: Tr = average recurrence period for event with;  
J = probability of occurrence  
n = design life in years

It is important to remember the correct interpretation of the recurrence interval. The recurrence interval of an event is the average period within which a given event will be equaled or exceeded. The selection of an acceptable risk level incorporates many factors including potential loss of life, downstream values, replacement costs, and regulatory issues. The Division will approve the use of design events less than the 10 year event for temporary or short term structures (usually access roads, construction staging areas, etc.)

To illustrate the concept of this evaluation, the following table presents return periods for projects with design lives of 2 years and 15 years for different risk levels:

Chance of Failure

Design Life:	30 percent	50 percent
2 years	7 year event	2 year event
15 years	43 year event	23 year event

The design life of the structure has a large role in the design event selection. A temporary structure, such as a culvert in an ephemeral channel for an exploration road to be used for a period less than a year, will have a relatively low recurrence interval for a given risk level when compared to more long term structures used for life of mine. A surface mine with temporary diversions constructed and reclaimed at relatively frequent intervals will utilize less stringent design events than those for most underground mine operations where structures are more long-term for the operational areas. These factors should all be considered when selecting the design event. The Division cautions operators against simply selecting the minimum design events specified in the regulations, those events may not meet the long term needs of the project or provide adequate protection of the project investment and downstream values.

b) Sensitivity Analysis of Different Design Event Criteria and Peak Flows

Precipitation data used in the runoff calculations for this paper were obtained from Estimated Return Periods For Short Duration Precipitation in Utah (DOGM files). The Clear Creek gaging station was chosen because it is an upland site and its proximity to a coal mine. Also of concern was a site subject to precipitation events that would significantly exceed the initial abstraction of the assumed watershed(s). Storm recurrence intervals, durations and the associated precipitation are:

Precipitation Event	Total Precipitation From Event
2 year 6 hour	1.04 inches
10 year 6 hour	1.55 inches
25 year 6 hour	1.88 inches
100 year 6 hour	2.29 inches

In order to perform runoff calculations, it was necessary to assume certain watershed characteristics. The following values were chosen as a best estimate of an "average" disturbed and undisturbed watershed encountered by coal mines in Utah. The time of concentration is not an assumed value, but rather, a value calculated from all the other parameters. Time of concentration is a constant for all calculations, so it is included here. Watershed characteristics are:

Disturbed Watershed Characteristics
Hydraulic Length = 500 feet
Curve Number (CN) = 88
Slope (S) = 4% = 2.3°
Area (A) = 5 acres
Manning's "n" = .03
Time of Concentration (T <sub>c</sub> ) = .1155 hours

Undisturbed Watershed Characteristics	
Hydraulic Length = 1200 feet	
Curve Number (CN) = 75	
Slope (S) = 45% = 24°	
Area (A) = 30 acres	
Manning's "n" = .03	
Time of Concentration (T <sub>c</sub> ) = .1061 hours	

Given the precipitation data and watershed characteristics listed above, runoff calculations using the Division's Peak Flow program (Hawkins, et. al) yielded the following values for the disturbed watershed:

Disturbed Watershed Peak Flows				
Recurrence Interval Duration	2 year 6 hour	10 year 6 hour	25 year 6 hour	100 year 6 hour
Runoff Depth	0.2763 in.	0.6178 in.	0.8695 in.	1.2036 in.
Initial Abstraction	0.2727 in.	0.2727 in.	0.2727 in.	0.2727 in.
Peak Flow Time To Peak	1.23 cfs 2.53 hrs	2.86 cfs 2.53 hrs	4.04 cfs 2.51 hrs	5.57 cfs 2.51 hrs

while the undisturbed watershed values are:

Undisturbed Watershed Peak Flows				
Recurrence Interval Duration	2 year 6 hour	10 year 6 hour	25 year 6 hour	100 year 6 hour
Runoff Depth	0.0376 in.	0.1850 in.	0.3238 in.	0.5316 in.
Initial Abstraction	0.6667 in.	0.6667 in.	0.6667 in.	0.6667 in.
Peak Flow Time To Peak	0.47 cfs 6.01 hrs	3.53 cfs 2.55 hrs	7.76 cfs 2.53 hrs	13.95 cfs 2.53 hrs



c) Impact of Different Design Event Flows on Channel Size.

Using the peak flow values generated, typical diversions to handle the design event are designed. For disturbed diversions, it was assumed that the bottom width would be one (1) foot; left and right side slopes would be 2:1; Manning's "n" equal to 0.03; and a channel slope of 0.04. Using the Open Channel Flow Module (Haestad Methods), it was the possible to solve for the minimum channel depth. The table below does not contain any considerations for freeboard. Minimum channel depths are:

Minimum Channel Depth for Disturbed Area Diversions				
Recurrence Interval Duration	2 year 6 hour	10 year 6 hour	25 year 6 hour	100 year 6 hour
Peak Flow To Pass	1.23 cfs	2.86 cfs	4.04 cfs	5.57 cfs
Channel Depth	0.26 feet	0.40 feet	0.47 feet	0.55 feet

For undisturbed diversions, it was assumed that the bottom width would be 1.5 feet; left and right side slopes would be 2:1; Manning's "n" equal to 0.03; and a channel slope of 0.04. The channel slope value was chosen because it was assumed that the undisturbed diversion would be along the perimeter of the disturbed area and as such would have the same channel slope as disturbed diversions. Using the Open Channel Flow Module (Haestad Methods), it was then possible to solve for the minimum channel depth. The table below does not contain any considerations for freeboard. Minimum channel depths are:

Minimum Channel Depth for Undisturbed Area Diversions				
Recurrence Interval Duration	2 year 6 hour	10 year 6 hour	25 year 6 hour	100 year 6 hour
Peak Flow To Pass	0.47 cfs	3.53 cfs	7.76 cfs	13.95 cfs
Channel Depth	0.12 feet	0.38 feet	0.57 feet	0.77 feet

Graphs (Attachment B) illustrate peak flows versus event recurrence interval for disturbed and undisturbed watersheds as well as minimum channel depth versus event recurrence interval for disturbed and undisturbed watersheds. **These graphs demonstrate that diversions of disturbed and undisturbed miscellaneous flows based on the 10 year 6 hour event are not significantly larger than those based on the 2 year 6 hour event.** For both design events, the channel depth is less than 0.5 feet. While these values are based on

calculations using assumed watersheds and assumed channel specifications, the results indicate that, on average, channel design based on the 10 year 6 hour precipitation event is not appreciably larger than that of the 2 year 6 hour event. In addition, implementing such design would not be significantly more cost intensive.

Summaries from the Peak program and the Open Channel Flow Module are found in Attachment B.

#### IV. SUMMARY OF WESTERN STATES COAL REGULATORY PROGRAM DIVERSION DESIGN REQUIREMENTS

Many states use "the last line of defense" philosophy when sizing ditches, so that if a failure occurs, the minimum design criteria is the 10yr.-24hr. storm event for the most downstream disturbed area diversion. While the Division does not require this design criteria, it is recommended that operators consider the design philosophy for incorporation into their respective drainage plans. The following table summarizes design practices currently in use in the western region:

State	Temporary	Permanent	Exemptions
Arizona	10yr-6hr	Ephemeral 10yr-6hr Intermittent & Perennial 100yr-6hr	
Colorado	10yr-24hr	100yr-24hr	2yr-24 temp. + 10yr-24hr perm. *
Montana	10yr-24hr	100yr-24hr	2yr-24hr roadside ditches
New Mexico	Overland Flow: 2yr-24hr Last Line Of Defense: 10yr-24hr	Ephemeral 10yr-24-hr Intermittent & Perennial 100yr-24hr	
Utah	10yr-6hr	Ephemeral 10yr.-6hr- Intermittent & Perennial 100yr-6hr	2yr-6hr temp. (in place only months) *
Wyoming	Intermittent & perennial: < 3 yrs.: 10yr-6hr 3-10 yrs.: 25yr-6hr 11-20yrs.: 50yr-6hr > 20 yrs.: 100yr-6hr Ephemeral: 2yr-6hr	100yr-6hr	Based on Probability of Failure

\* not desired alternatives but allowed under special circumstances.

Proposed Utah Criteria

	Temporary	Permanent	Exemptions
Utah	Short-term Ditch (<6 mos.): 2yr.-6hr. Disturbed Area Diversions: 10yr.-6hr.	Ephemeral Intermittent Perennial 1) Meet Upstream Downstream Predisturbance Profile and Cross-section 2) 100yr.-6hr.*	* A 10yr.-6hr Criteria For Permanent Ephemeral Ditches is Acceptable After Meeting Condition 1

**V. CONCLUSIONS AND PERMITTING GUIDANCE**

The Division's permitting guidance on the use of the 2 yr. - 6 hr. precipitation event criteria for the design of miscellaneous flows remains unchanged from past practice. Procedurally, the permitting process remains consistent and the intent of this guideline is to formalize current and past permitting practices. The Division is not disallowing the use of this rule, the 2 yr. criteria does have merit and intent for specific cases. In practice, those cases where the Division will approve diversions for miscellaneous flows designed for the 2 yr. - 6 hr. event will be for diversions to be constructed and removed in a short time period. This time period will typically be on the order of several months to a year maximum. Examples would include an access road culvert for construction of a substation, a drainage plan for a staging area for construction, or drainage control for exploration projects. It must be emphasized that this is a guideline, individual reviewers have full authority to approve diversions designed using the 2 yr. event criteria based upon site conditions, the diversion design life and intended use, downstream values, and level of protection warranted.

Designs for diversions of miscellaneous flows that are integral to the operational drainage plan for the life of the surface facilities should be based upon the 10 yr. - 6 hr. precipitation event. Prudent engineering would dictate that diversions to sediment ponds would be based upon the 10 yr. - 24 hr. event to ensure consistency with the pond design criteria. The adopted rules do not mandate this design criteria ( 10 yr. - 24 hr.), however, the Division should encourage and explain the benefits and merits of this criteria to applicants when given the opportunity.

When approving a short term diversion based upon the 2 yr. - 6 hr. event, reviewers should ensure that the MRP reflects a commitment to remove the diversion within a specific

timeframe and that a contemporaneous reclamation plan specific to that location is explicit in the MRP. Further basis for this requirement is found in R645-301-742.313:

"Temporary diversions will be removed when no longer needed to achieve the purpose for which they were authorized. The land disturbed by the removal process will be restored in accordance with R645-301 and R645-302. Before diversions are removed, downstream water-treatment facilities previously protected by the diversion will be modified or removed, as necessary, to prevent overtopping or failure of the facilities. This requirement will not relieve the operator from maintaining water-treatment facilities as otherwise required..".

**VI. SUMMARY OF DIVERSION DESIGN EVENT CRITERIA CURRENTLY USED BY COAL OPERATORS IN UTAH**

Attachment C summarizes current design criteria and diversion designs contained in our approved MRP documents. The section demonstrates that operators are currently using the 10 year return period standard for the design criteria. The storm duration used (6 hour vs. 24 hour) is reflective of the design criteria changes incorporated with the adoption of the R614 (and subsequent R645) rules. The use of the 10 yr. - 6 hr. criteria will provide for a more prudent, lower risk diversion that can be constructed without significant increased cost in most cases.

cc: L. Braxton  
P. Grubaugh-Littig  
D. Haddock

2YREVNT.RPS

## **"ATTACHMENT A'**

### **RELEVANT REGULATIONS TO POSITION PAPER TEMPORARY DIVERSIONS OF MISCELLANEOUS FLOWS**

#### **CURRENT RULES (R645-301, ET. SEQ.):**

- 732.300. Diversions. All diversions will be constructed and maintained to comply with the requirements of R645-301-742.100 and R645-301-742.300.
- 742.300. Diversions.
- 742.310. General Requirements.
- 742.311. With the approval of the Division, any flow from mined areas abandoned before May 3, 1978, and any flow from undisturbed areas or reclaimed areas, after meeting the criteria of R645-301-356.300, R645-301-356.400, R645-301-513.200, R645-301-742.200 through R645-301-742.240, and R645-301-763 for siltation structure removal, may be diverted from disturbed areas by means of temporary or permanent diversions. All diversions will be designed to minimize adverse impacts to the hydrologic balance within the permit and adjacent areas, to prevent material damage outside the permit area and to assure the safety of the public. Diversions will not be used to divert water into underground mines without approval of the Division in accordance with R645-301-731.510.
- 742.312. The diversion and its appurtenant structures will be designed, located, constructed, maintained and used to:
  - 742.312.1. Be stable;
  - 742.312.2. Provide protection against flooding and resultant damage to life and property;
  - 742.312.3. Prevent, to the extent possible using the best technology currently available, additional contributions of suspended solids to streamflow outside the permit area; and
  - 742.312.4. Comply with all applicable local, Utah, and federal laws and regulations.

- 742.313. Temporary diversions will be removed when no longer needed to achieve the purpose for which they were authorized. The land disturbed by the removal process will be restored in accordance with R645-301 and R645-302. Before diversions are removed, downstream water-treatment facilities previously protected by the diversion will be modified or removed, as necessary, to prevent overtopping or failure of the facilities. This requirement will not relieve the operator from maintaining water-treatment facilities as otherwise required. A permanent diversion or a stream channel reclaimed after the removal of a temporary diversion will be designed and constructed so as to restore or approximate the premining characteristics of the original stream channel including the natural riparian vegetation to promote the recovery and the enhancement of the aquatic habitat.
- 742.314. The Division may specify additional design criteria for diversions to meet the requirements of R645-301-742.300.
- 742.320. Diversion of Perennial and Intermittent Streams.
- 742.321. Diversion of perennial and intermittent streams within the permit area may be approved by the Division after making the finding relating to stream buffer zones under R645-301-731.600.
- 742.322. The design capacity of channels for temporary and permanent stream channel diversions will be at least equal to the capacity of the unmodified stream channel immediately upstream and downstream from the diversion.
- 742.323. The requirements of R645-301-742.312.2 will be met when the temporary and permanent diversion for perennial and intermittent streams are designed so that the combination of channel, bank and floodplain configuration is adequate to pass safely the peak runoff of a 10-year, 6-hour precipitation event for a temporary diversion and a 100-year, 6-hour precipitation event for a permanent diversion.
- 742.324. The design and construction of all stream channel diversions of perennial and intermittent streams will be certified by a qualified registered professional engineer as meeting the performance standards of R645-301 and R645-302 and any design criteria set by the Division.

- 742.330. Diversion of Miscellaneous Flows.
- 742.331. Miscellaneous flows, which consist of all flows except for perennial and intermittent streams, may be diverted away from disturbed areas if required or approved by the Division. Miscellaneous flows will include ground-water discharges and ephemeral streams.
- 742.332. The design, location, construction, maintenance, and removal of diversions of miscellaneous flows will meet all of the performance standards set forth in R645-301-742.310.
- 742.333. The requirements of R645-301-742.312.2 will be met when the temporary and permanent diversions for miscellaneous flows are designed so that the combination of channel, bank and floodplain configuration is adequate to pass safely the peak runoff of a 2-year, 6-hour precipitation event for a temporary diversion and a 10-year, 6-hour precipitation event for a permanent diversion.

#### PREVIOUS RULES (UMC 817.43 RULES):

- UMC 817.43 (a) Temporary diversions shall be constructed to pass safely the peak runoff from a precipitation event with a two-year recurrence interval, or a larger event as specified by the Division. However, temporary diversions designed to divert runoff from sediment ponds must be designed and constructed to pass safely the peak runoff from a 10-year, 24 hour precipitation event (emphasis added).

#### FEDERAL RULES

##### Sec. 817.43 Diversions.

FEDERAL REGISTER CITE: 48 CFR 43955 (43993)

PUBLISHED DATE: 09/26/83

EFFECTIVE DATE: 10/26/83

- (a) General requirements. (1) With the approval of the regulatory authority, any flow from mined areas abandoned before May 3, 1978, and any flow from undisturbed areas or

reclaimed areas, after meeting the criteria of Section 817.46 for siltation structure removal, may be diverted from disturbed areas by means of temporary or permanent diversions. All diversions shall be designed to minimize adverse impacts to the hydrologic balance within the permit and adjacent areas, to prevent material damage outside the permit area and to assure the safety of the public. Diversions shall not be used to divert water into underground mines without approval of the regulatory authority in accordance with Section 817.41(h).

(2) The diversion and its appurtenant structures shall be designed, located, constructed, and maintained to--

- (i) Be stable;
- (ii) Provide protection against flooding and resultant damage to life and property;
- (iii) Prevent, to the extent possible using the best technology currently available, additional contributions of suspended solids to streamflow outside the permit area; and
- (iv) Comply with all applicable local, State, and Federal laws and regulations.

(3) Temporary diversions shall be removed when no longer needed to achieve the purpose for which they were authorized. The land disturbed by the removal process shall be restored in accordance with this part. Before diversions are removed, downstream water-treatment facilities previously protected by the diversion shall be modified or removed, as necessary, to prevent overtopping or failure of the facilities. This requirement shall not relieve the operator from maintaining water-treatment facilities as otherwise required. A permanent diversion or a stream channel reclaimed after the removal of a temporary diversion shall be designed and constructed so as to restore or approximate the premining characteristics of the original stream channel including the natural riparian vegetation to promote the recovery and the enhancement of the aquatic habitat.

(4) The regulatory authority may specify additional design criteria for diversions to meet the requirements of this Section.

(b) Diversion of perennial and intermittent streams.

(1) Diversion of perennial and intermittent streams within the permit area may be approved by the regulatory authority after making the finding relating to stream buffer zones called for in Section 817.57 that the diversions will not adversely affect the water quantity and quality and related environmental resources of the stream.

(2) The design capacity of channels for temporary and permanent stream channel diversions shall be at least equal to the capacity of the unmodified stream channel immediately upstream and downstream from the diversion.

(3) The requirements of Paragraph (a)(2)(ii) of this Section shall be met when the temporary and permanent diversions for perennial and intermittent streams are designed so that the combination of channel, bank and flood-plain configuration is adequate to pass safely the peak runoff of a 10-year, 6-hour precipitation event for a temporary diversion and a 100-year, 6-hour precipitation event for a permanent diversion.

(4) The design and construction of all stream channel diversions of perennial and intermittent streams shall be certified by a qualified registered professional engineer as



meeting the performance standards of this part and any design criteria set by the regulatory authority.

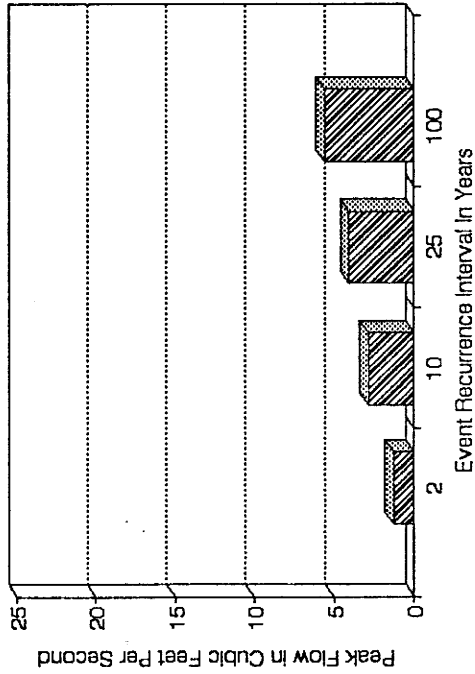
(c) Diversion of miscellaneous flows. (1) Miscellaneous flows, which consist of all flows except for perennial and intermittent streams, may be diverted away from disturbed areas if required or approved by the regulatory authority. Miscellaneous flows shall include ground-water discharges and ephemeral streams.

(2) The design, location, construction, maintenance, and removal of diversions of miscellaneous flows shall meet all of the performance standards set forth in Paragraph (a) of this Section.

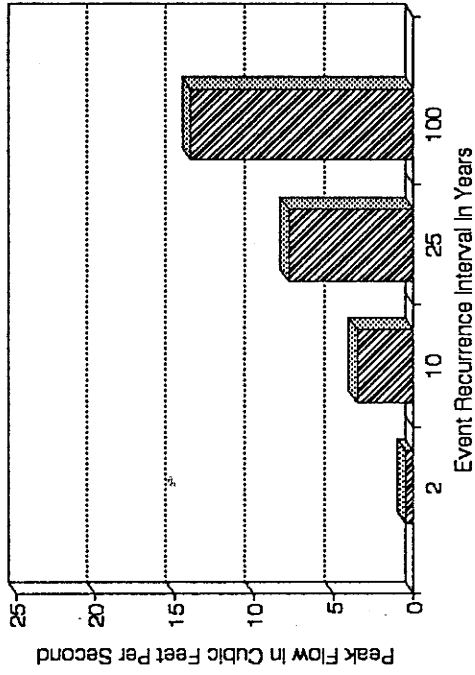
(3) The requirements of Paragraph (a)(2)(ii) of this Section shall be met when the temporary and permanent diversions for miscellaneous flows are designed so that the combination of channel, bank and flood-plain configuration is adequate to pass safely the peak runoff of a 2-year, 6-hour precipitation event for a temporary diversion and a 10-year, 6-hour precipitation event for a permanent diversion.

# ATTACHMENT B

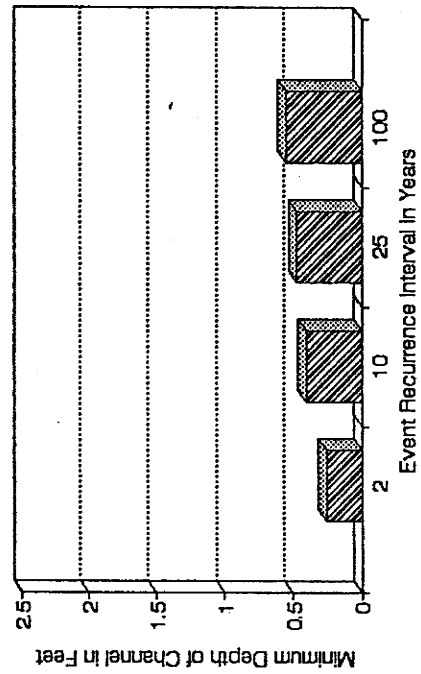
Disturbed Watershed Peak Flows



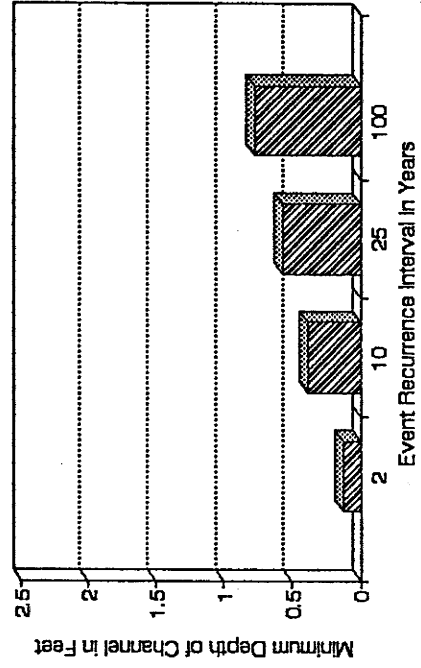
Undisturbed Watershed Peak Flows



Disturbed Diversion Channel Design:  
Depth Required To Pass Peak Flows



Undisturbed Diversion Channel Design:  
Depth Required To Pass Peak Flows



INPUT SUMMARY

FOR W.S.: Disturbed 2 year 6 hour event

STORM:

WATERSHED:

DISTRIBUTION =SCS TYPE 'B'

LAND SLOPE = 4.0000 PCT

PRECIP.DEPTH = 1.04 IN

CURVE NUMBER = 88.00

DURATION = 6.00 HR

CHANNEL LENGTH = 500.00 FT

TIME OF CONC. = 0.1155 HR

NUMBER OF LINES = 405

AREA = 5.00 AC

D = 0.0154 HR

OUTPUT SUMMARY

RUNOFF DEPTH = 0.2763 IN

INITIAL ABSTRACTION = 0.2727 IN

PEAK FLOW = 1.23 CFS ( 0.2436 IPH)

AT T = 2.53 HRS

INPUT SUMMARY

FOR W.S.: Disturbed 10 year 6 hour event

STORM:

WATERSHED:

DISTRIBUTION =SCS TYPE 'B'

LAND SLOPE = 4.0000 PCT

PRECIP.DEPTH = 1.55 IN

CURVE NUMBER = 88.00

DURATION = 6.00 HR

CHANNEL LENGTH = 500.00 FT

TIME OF CONC. = 0.1155 HR

NUMBER OF LINES = 405

AREA = 5.00 AC

D = 0.0154 HR

OUTPUT SUMMARY

RUNOFF DEPTH = 0.6178 IN

INITIAL ABSTRACTION = 0.2727 IN

PEAK FLOW = 2.86 CFS ( 0.5670 IPH)

AT T = 2.53 HRS

INPUT SUMMARY

FOR W.S.: Disturbed 25 year 6 hour event

STORM:

WATERSHED:

DISTRIBUTION =SCS TYPE 'B'

LAND SLOPE = 4.0000 PCT

PRECIP.DEPTH = 1.88 IN

CURVE NUMBER = 88.00

DURATION = 6.00 HR

CHANNEL LENGTH = 500.00 FT

NUMBER OF LINES = 405

TIME OF CONC. = 0.1155 HR

AREA = 5.00 AC

D = 0.0154 HR

OUTPUT SUMMARY

RUNOFF DEPTH = 0.8695 IN

INITIAL ABSTRACTION = 0.2727 IN

PEAK FLOW = 4.04 CFS ( 0.8005 IPH)

AT T = 2.51 HRS

INPUT SUMMARY

FOR W.S.: Disturbed 100 year 6 hour event

STORM:

WATERSHED:

DISTRIBUTION =SCS TYPE 'B'

LAND SLOPE = 4.0000 PCT

PRECIP.DEPH = 2.29 IN

CURVE NUMBER = 88.00

DURATION = 6.00 HR

CHANNEL LENGTH = 500.00 FT

TIME OF CONC. = 0.1155 HR

NUMBER OF LINES = 405

AREA = 5.00 AC

D = 0.0154 HR

OUTPUT SUMMARY

RUNOFF DEPTH = 1.2036 IN

INITIAL ABSTRACTION = 0.2727 IN

PEAK FLOW = 5.57 CFS ( 1.1050 IPH)

AT T = 2.51 HRS

INPUT SUMMARY

FOR W.S.: Undisturbed 2 year 6 hour event

STORM:

WATERSHED:

DISTRIBUTION =SCS TYPE 'B'

LAND SLOPE = 45.0000 PCT

PRECIP.DEPTH = 1.04 IN

CURVE NUMBER = 75.00

DURATION = 6.00 HR

CHANNEL LENGTH = 1200.00 FT

TIME OF CONC. = 0.1061 HR

NUMBER OF LINES = 440

AREA = 30.00 AC

D = 0.0141 HR

OUTPUT SUMMARY

RUNOFF DEPTH = 0.0376 IN

INITIAL ABSTRACTION = 0.6667 IN

PEAK FLOW = 0.47 CFS ( 0.0157 IPH)

AT T = 6.01 HRS

INPUT SUMMARY

FOR W.S.: Undisturbed 10 year 6 hour event

STORM:

WATERSHED:

DISTRIBUTION =SCS TYPE 'B'

LAND SLOPE = 45.0000 PCT

RECIP.DEPTH = 1.55 IN

CURVE NUMBER = 75.00

DURATION = 6.00 HR

CHANNEL LENGTH = 1200.00 FT

TIME OF CONC. = 0.1061 HR

NUMBER OF LINES = 440

AREA = 30.00 AC

D = 0.0141 HR

OUTPUT SUMMARY

RUNOFF DEPTH = 0.1850 IN

INITIAL ABSTRACTION = 0.6667 IN

PEAK FLOW = 3.53 CFS ( 0.1168 IPH)

AT T = 2.55 HRS



INPUT SUMMARY

FOR W.S.: Undisturbed 25 year 6 hour event

STORM:

WATERSHED:

DISTRIBUTION =SCS TYPE 'B'

LAND SLOPE = 45.0000 PCT

PRECIP.DEPTH = 1.88 IN

CURVE NUMBER = 75.00

DURATION = 6.00 HR

CHANNEL LENGTH = 1200.00 FT

NUMBER OF LINES = 440

TIME OF CONC. = 0.1061 HR

AREA = 30.00 AC

D = 0.0141 HR

OUTPUT SUMMARY

RUNOFF DEPTH = 0.3238 IN

INITIAL ABSTRACTION = 0.6667 IN

PEAK FLOW = 7.76 CFS ( 0.2564 IPH)

AT T = 2.53 HRS

INPUT SUMMARY

FOR W.S.: Undisturbed 100 year 6 hour event

-----  
STORM:

WATERSHED:

-----  
DISTRIBUTION =SCS TYPE 'B'

LAND SLOPE = 45.0000 PCT

PRECIP.DEPTH = 2.29 IN

CURVE NUMBER = 75.00

DURATION = 6.00 HR

CHANNEL LENGTH = 1200.00 FT

NUMBER OF LINES = 440

TIME OF CONC. = 0.1061 HR

AREA = 30.00 AC

D = 0.0141 HR  
-----

OUTPUT SUMMARY

-----  
RUNOFF DEPTH = 0.5316 IN

INITIAL ABSTRACTION = 0.6667 IN

PEAK FLOW = 13.95 CFS ( 0.4611 IPH)

AT T = 2.53 HRS  
-----

Trapezoidal Channel Analysis & Design  
Open Channel - Uniform flow

Worksheet Name: Disturbed

Comment: 2 year 6 hour event

Solve For Depth

Given Input Data:

Bottom Width.....	1.00 ft
Left Side Slope..	2.00:1 (H:V)
Right Side Slope.	2.00:1 (H:V)
Manning's n.....	0.030
Channel Slope....	0.0400 ft/ft
Discharge.....	1.23 cfs

Computed Results:

Depth.....	0.26 ft
Velocity.....	3.17 fps
Flow Area.....	0.39 sf
Flow Top Width...	2.03 ft
Wetted Perimeter.	2.15 ft
Critical Depth...	0.29 ft
Critical Slope...	0.0238 ft/ft
Froude Number....	1.28 (flow is Supercritical)

Trapezoidal Channel Analysis & Design  
Open Channel - Uniform flow

Worksheet Name: Disturbed

Comment: 10 year 6 hour event

Solve For Depth

Given Input Data:

Bottom Width.....	1.00 ft
Left Side Slope..	2.00:1 (H:V)
Right Side Slope.	2.00:1 (H:V)
Manning's n.....	0.030
Channel Slope....	0.0400 ft/ft
Discharge.....	2.86 cfs

Computed Results:

Depth.....	0.40 ft
Velocity.....	4.00 fps
Flow Area.....	0.71 sf
Flow Top Width...	2.59 ft
Wetted Perimeter.	2.78 ft
Critical Depth...	0.47 ft
Critical Slope...	0.0213 ft/ft
Froude Number....	1.34 (flow is Supercritical)

Trapezoidal Channel Analysis & Design  
Open Channel - Uniform flow

Worksheet Name: Disturbed

Comment: 25 year 6 hour event

Solve For Depth

Given Input Data:

Bottom Width.....	1.00 ft
Left Side Slope..	2.00:1 (H:V)
Right Side Slope.	2.00:1 (H:V)
Manning's n.....	0.030
Channel Slope....	0.0400 ft/ft
Discharge.....	4.04 cfs

Computed Results:

Depth.....	0.47 ft
Velocity.....	4.39 fps
Flow Area.....	0.92 sf
Flow Top Width...	2.89 ft
Wetted Perimeter.	3.11 ft
Critical Depth...	0.56 ft
Critical Slope...	0.0204 ft/ft
Froude Number....	1.37 (flow is Supercritical)

Trapezoidal Channel Analysis & Design  
Open Channel - Uniform flow

Worksheet Name: Disturbed

Comment: 100 year 6 hour event

Solve For Depth

Given Input Data:

Bottom Width.....	1.00 ft
Left Side Slope..	2.00:1 (H:V)
Right Side Slope.	2.00:1 (H:V)
Manning's n.....	0.030
Channel Slope....	0.0400 ft/ft
Discharge.....	5.57 cfs

Computed Results:

Depth.....	0.55 ft
Velocity.....	4.78 fps
Flow Area.....	1.16 sf
Flow Top Width...	3.21 ft
Wetted Perimeter.	3.47 ft
Critical Depth...	0.66 ft
Critical Slope...	0.0196 ft/ft
Froude Number....	1.40 (flow is Supercritical)

Trapezoidal Channel Analysis & Design  
Open Channel - Uniform flow

Worksheet Name: Undisturbed

Comment: 2 year 6 hour event

Solve For Depth

Given Input Data:

Bottom Width.....	1.50 ft
Left Side Slope..	2.00:1 (H:V)
Right Side Slope.	2.00:1 (H:V)
Manning's n.....	0.030
Channel Slope....	0.0400 ft/ft
Discharge.....	0.47 cfs

Computed Results:

Depth.....	0.12 ft
Velocity.....	2.20 fps
Flow Area.....	0.21 sf
Flow Top Width...	1.99 ft
Wetted Perimeter.	2.05 ft
Critical Depth...	0.14 ft
Critical Slope...	0.0279 ft/ft
Froude Number....	1.18 (flow is Supercritical)

Trapezoidal Channel Analysis & Design  
Open Channel - Uniform flow

Worksheet Name: Undisturbed

Comment: 10 year 6 hour event

Solve For Depth

Given Input Data:

Bottom Width.....	1.50 ft
Left Side Slope..	2.00:1 (H:V)
Right Side Slope.	2.00:1 (H:V)
Manning's n.....	0.030
Channel Slope....	0.0400 ft/ft
Discharge.....	3.53 cfs

Computed Results:

Depth.....	0.38 ft
Velocity.....	4.12 fps
Flow Area.....	0.86 sf
Flow Top Width...	3.02 ft
Wetted Perimeter.	3.20 ft
Critical Depth...	0.45 ft
Critical Slope...	0.0207 ft/ft
Froude Number....	1.36 (flow is Supercritical)



Trapezoidal Channel Analysis & Design  
Open Channel - Uniform flow

Worksheet Name: Undisturbed

Comment: 25 year 6 hour event

Solve For Depth

Given Input Data:

Bottom Width.....	1.50 ft
Left Side Slope..	2.00:1 (H:V)
Right Side Slope.	2.00:1 (H:V)
Manning's n.....	0.030
Channel Slope....	0.0400 ft/ft
Discharge.....	7.76 cfs

Computed Results:

Depth.....	0.57 ft
Velocity.....	5.13 fps
Flow Area.....	1.51 sf
Flow Top Width...	3.79 ft
Wetted Perimeter.	4.06 ft
Critical Depth...	0.69 ft
Critical Slope...	0.0187 ft/ft
Froude Number....	1.43 (flow is Supercritical)

Trapezoidal Channel Analysis & Design  
Open Channel - Uniform flow

Worksheet Name: Undisturbed

Comment: 100 year 6 hour event

Solve For Depth

Given Input Data:

Bottom Width.....	1.50 ft
Left Side Slope..	2.00:1 (H:V)
Right Side Slope.	2.00:1 (H:V)
Manning's n.....	0.030
Channel Slope....	0.0400 ft/ft
Discharge.....	13.95 cfs

Computed Results:

Depth.....	0.77 ft
Velocity.....	6.00 fps
Flow Area.....	2.32 sf
Flow Top Width...	4.57 ft
Wetted Perimeter.	4.93 ft
Critical Depth...	0.94 ft
Critical Slope...	0.0173 ft/ft
Froude Number....	1.48 (flow is Supercritical)

## **"ATTACHMENT C"**

### **DESIGN CRITERIA**

#### **Banning Siding Loadout (Soldier Creek Coal Company) #ACT/007/034**

Disturbed diversions at this mine are sized to pass the 10-year 24-hour event.  
Undisturbed diversions at this mine are sized to pass the 10-year 24-hour event.

#### **Bear Canyon Mine (Co-Op Mining Company) #ACT/015/025**

Disturbed diversions at this mine are sized to pass the 10-year 6-hour event.  
Undisturbed diversions at this mine are sized to pass the 10-year 6-hour event.  
Temporary diversions at this mine are sized to pass the 10-year 6-hour event.

#### **Belina Complex (Valley Camp of Utah, Inc.) #ACT/007/001**

Disturbed diversions at this mine are sized to pass the 10-year 6-hour event.  
Undisturbed diversions at this mine are sized to pass the 10-year 6-hour event.  
Permanent diversions at this mine are sized to pass the 100-year 6-hour event.

#### **Blackjack #1 Mine (New Tech Mining Corporation) #ACT/019/004**

Disturbed diversions at this mine are sized to pass the 10-year 24-hour event.  
Undisturbed diversions at this mine are sized to pass the 10-year 24-hour event.

#### **Blazon #1 Mine (North American Equities) #ACT/007/021**

Disturbed diversions at this mine are sized to pass the 10-year 24-hour event.  
Undisturbed diversions at this mine are sized to pass the 10-year 24-hour event.  
Permanent diversions at this mine are sized to pass the 100-year 24-hour event.

#### **Boyer Mine (Summit Coal Company) #ACT/043/008**

Disturbed diversions at this mine are sized to pass the 10-year 24-hour event.  
Undisturbed diversions at this mine are sized to pass the 10-year 24-hour event.  
Permanent diversions at this mine are sized to pass the 100-year 24-hour event.

#### **Castle Gate Mines (Amax Coal Company) #ACT/007/004**

Disturbed diversions at this mine are sized to pass the 10-year 6-hour event.  
Undisturbed diversions at this mine are sized to pass the 10-year 6-hour event.  
Permanent diversions at this mine are sized to pass the 100-year 6-hour event.

**Centennial Project (Andalex Resources, Inc.) #ACT/007/019**

Disturbed diversions at this mine are sized to pass the 10 year 24-hour event.  
Undisturbed diversions at this mine are sized to pass the 10 year 24-hour event.  
Permanent diversions at this mine are sized to pass the 100-year 24-hour event.

**Convulsion Canyon Mine (Southern Utah Fuel Company) #ACT/041/002**

Disturbed diversions at this mine are sized to pass the 10-year 6-hour event or the 10-year 24-hour event.  
Undisturbed diversions at this mine are sized to pass the 10-year 6-hour event.  
10-year 24-hour event.  
Permanent diversions at this mine are sized to pass the 100-year 6-hour event or the 100-year 24-hour event.

**Cottonwood/Wilberg Mine (PacifiCorp Electric Operations) #ACT/015/019**

Disturbed diversions at this mine are sized to pass the 10-year 6-hour event.  
Undisturbed diversions at this mine are sized to pass the 10-year 6-hour event.  
Permanent diversions at this mine are sized to pass the 100-year 24-hour event.

**Crandall Canyon Mine (Genwal Coal Company, Inc.) #ACT/015/032**

Disturbed diversions at this mine are sized to pass the 10-year 24-hour event.  
Undisturbed diversions at this mine are sized to pass the 25-year 24-hour event.  
Permanent diversions at this mine are sized to pass the 100-year 24-hour event.  
Temporary diversions at this mine are sized to pass the 10-year 24-hour event.

**C.V. Spur Preparation Plant (Mountain Coal Company) #ACT/007/022**

Disturbed diversions at this mine are sized to pass the 10-year 24-hour event.  
Undisturbed diversions at this mine are sized to pass the 10-year 24-hour event.  
Temporary diversions at this mine are sized to pass the 10-year 24-hour event.

**Deer Creek Mine (PacifiCorp Electric Operations) #ACT/015/018**

Disturbed diversions at this mine are sized to pass the 10-year 24-hour event.  
Undisturbed diversions at this mine are sized to pass the 50-year 6-hour event.

**Des-Bee-Dove Mine (PacifiCorp Electric Operations) #ACT/015/017**

Disturbed diversions at this mine are sized to pass the 10-year 6-hour event.  
Undisturbed diversions at this mine are sized to pass the 10-year 6-hour event.  
Temporary diversions at this mine are sized to pass the 10-year 6-hour event.

**Knight Mine (BHP Petroleum - Utah International, Inc.) #ACT/041/005**

Permanent diversions at this mine are sized to pass the 100-year 6-hour event.

**Skyline Mine (Utah Fuel Company) #ACT/007/005**

Disturbed diversions at this mine are sized to pass the 10-year 6-hour event or the 10-year 24-hour event.

Undisturbed diversions at this mine are sized to pass the 10-year 6-hour event. 10-year 24-hour event.

Permanent diversions at this mine are sized to pass the 100-year 24-hour event.

**Smokey Hollow Mine (Andalex Resources, Inc.) #PRO/025/002**

Disturbed diversions at this mine are sized to pass the 10-year 6-hour event or the 100-year 6-hour event.

Undisturbed diversions at this mine are sized to pass the 10-year 6-hour event. 100-year 6-hour event.

Permanent diversions at this mine are sized to pass the 100-year 6-hour event.

**Soldier Canyon Mine (Soldier Creek Coal Company) #ACT/007/018**

Disturbed diversions at this mine are sized to pass the 10-year 6-hour event or the 10-year 24-hour event.

Undisturbed diversions at this mine are sized to pass the 10-year 6-hour event. 10-year 24-hour event.

Permanent diversions at this mine are sized to pass the 100-year 6-hour event or the 100-year 24-hour event.

**Star Point Mine (Cyprus Plateau Mining Corporation) #ACT/007/006**

Disturbed diversions at this mine are sized to pass the 10-year 24-hour event.

Undisturbed diversions at this mine are sized to pass the 10-year 24-hour event.

Temporary diversions at this mine are sized to pass the 10-year 24-hour event.

**Summit #1 Mine-Blackhawk (Summit Minerals, Inc.) #ACT/043/001**

Disturbed diversions at this mine are sized to pass the 10-year 24-hour event.

Undisturbed diversions at this mine are sized to pass the 10-year 24-hour event.

**Sunnyside Mine (Sunnyside Coal Company) #ACT/007/007**

Disturbed diversions at this mine are sized to pass the 10-year 24-hour event.

Undisturbed diversions at this mine are sized to pass the 10-year 24-hour event.

**Trail Canyon Mine (Co-Op Mining Company) #ACT/015/021**

Disturbed diversions at this mine are sized to pass the 10-year 24-hour event.  
Undisturbed diversions at this mine are sized to pass the 100-year 24-hour event.  
Permanent diversions at this mine are sized to pass the 50-year 24-hour event.

**Trail Mountain Mine (Mountain Coal Company) #ACT/015/009**

Disturbed diversions at this mine are sized to pass the 10-year 24-hour event.  
Undisturbed diversions at this mine are sized to pass the 10-year 24-hour event for the Side Canyon culvert and the 50-year 24-hour event for Cottonwood Creek.  
Permanent diversions at this mine are sized to pass the 100-year 24-hour event.  
Temporary diversions at this mine are sized to pass the 10-year 24-hour event.

**Wellington Preparation Plant (Castle Valley Resources) #ACT/007/012**

Disturbed diversions at this mine are sized to pass the 10-year 6-hour event.  
Undisturbed diversions at this mine are sized to pass the 100-year 6-hour event around the loadout facility and 100-year 6-hour event around the upper refuse basin.  
Permanent diversions at this mine are sized to pass the 100-year 6-hour event.

**Wildcat Loadout (Andalex Resources, Inc.) #ACT/007/033**

Undisturbed diversions at this mine are sized to pass the 100-year 24-hour event.  
Permanent diversions at this mine are sized to pass the 100-year 24-hour event.